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A NEW CRAYFISH FROM THE CUMBERLAND RIVER SYSTEM WITH NOTES ON *CAMBARUS CAROLINUS* (ERICHSON)

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The two species treated here have been so often confused with other crayfishes that to aid in avoiding further errors, we offer descriptions together with all information available to us concerning them, including as complete synonymies as possible. While their relationships to other allied members of the complexes to which they belong are not adequately understood, we hope that the descriptions and information presented here will be helpful to future investigators.

The existence of *Cambarus* (*Puncticambarus*) *cumberlandensis*, new species, has been known since 1905 when Ortmann identified crayfish from the Rockcastle River in Kentucky as *Cambarus extraneus* Hagen, 1870. All subsequent authors treating this crayfish, which frequents the Cumberland and upper Green drainage systems, have utilized his determination, largely because of a lack of knowledge as to the identity of *Cambarus extraneus*, which, insofar as we know, is confined to one tributary, South Chickamauga Creek, of the Tennessee River in southeastern Tennessee and northwestern Georgia. That portion of the Tennessee drainage system lying between the ranges of *C. cumberlandensis* and *C. extraneus* is occupied by another species of the subgenus *Puncticambarus* that is being described by one of us (Bouchard, see Relationships).

Our knowledge of *Cambarus carolinus* Erichson, 1846, has been in a state of chaos since this crayfish was first described.

The type, which has been lost, was deposited in the Berlin Museum, and the only students of crayfishes who are known to have seen it were Erichson and Hagen. It is unfortunate that the latter did not examine it until after he had prepared his monograph (1870) of the North American crayfishes. Both Faxon and Hay had access to a photograph of the type and drawings of the chela and first pleopod, but the whereabouts of the photograph and the sketches is not known. The only specimens considered here to be typical of *C. carolinus* are those collected near the type-locality. With the exception of the lost type, specimens from southwestern North Carolina, and those cited here, all specimens, to which references have been made in other contributions, belong either to *Cambarus dubius* Faxon, 1884, or to one or more species cited below. Because of inadequate series of these difficult-to-capture burrowers, descriptions of those believed to be new are being delayed until additional specimens can be acquired. Less than half of the references to *C. carolinus* actually refer to that species; hence, to avoid possible misinterpretations of our analysis of the synonymy presented, we are appending all remaining citations to *C. carolinus* that we believe applicable to other species.

Acknowledgments: We are most grateful to all of those persons cited herein who assisted us in collecting, or who donated to us, specimens of the species treated here. Especial thanks are extended to George F. Townes and John J. Huebner for their interest and assistance in locating the type-locality of *Cambarus carolinus*. Our appreciation is also extended to Carolyn B. Gast for the illustrations, and to Fenner A. Chace, Jr., and Margaret A. Daniel for their critical review of the manuscript.

Cambarus (Puncticambarus) cumberlandensis, new species

Cambarus extraneus.—Ortmann, 1905a:310*–311*; 1905b:121*, 134; 1918:849*; 1931:97*, 99*, 102*–104*, 105.—Fleming, 1938:300*, 303*; 1939:311*.—Hobbs and Shoup, 1942:634, 636–639.—Rhoades, 1944:112, 114, 134, 136*.—Hobbs, 1956:116*, 120*.—Holt, 1968: 20, 28.

Cambarus extraneous.—Cole, 1959:81 (erroneous spelling).

* In part.

Cambarus (*Puncticambarus*) sp. A.—Hobbs, 1969:102, 133, 134 (Fig. 7).

Diagnosis: Body and eyes with pigment. Rostrum with marginal spines or tubercles. Areola 3.5 to 5.3 times longer than broad and constituting 31.6 to 37.3 percent of total length of carapace (41.6 to 46.6 percent of postorbital length) with 6 to 9 punctations across narrowest part. Cervical spines almost always well developed; hepatic spines absent; branchiostegal spine present; suborbital angle usually acute; postorbital ridge moderately strong and terminating in spine or acute tubercle. Antennal scale approximately 2.5 times longer than broad, broadest slightly distal to midlength. Chela with 2 rows of 6 to 9 tubercles on mesial surface of palm; lateral margin strongly costate and lateral base of fixed finger strongly impressed above and below; dactyl at least twice as long as mesial margin of palm. Hook on ischium of third pereiopods of male overreaching basioischial articulation and opposed by tubercle on basis. First pleopod of first form male with central projection corneous, bladelike, bearing distinct subapical notch, recurved at angle of approximately 110 degrees, and constituting, if straightened, approximately one-fifth total length of appendage; mesial process tumescent, tapering to subacute tip, and directed caudolaterally at angle of approximately 90 degrees to shaft of appendage. Annulus ventralis symmetrical, subquadrangular, with caudal portion somewhat movable; cephalic half bearing longitudinal median trough between longitudinal ridges, and caudal half with tilted S-shaped sinus. First pleopod of female uniramous and reaching midlength of annulus when abdomen flexed.

Holotypic male, form I: Body subovate, depressed (Fig. 1*a*, *j*). Abdomen narrower than thorax (22.5 and 27.9 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (27.9 and 18.5 mm). Areola 4.9 times longer than wide with 6 to 8 punctations across narrowest part; length of areola 34.3 percent of entire length of carapace (41.3 percent of postorbital length). Rostrum with weakly thickened, convergent margins bearing prominent acute, corneous tubercles at base of acumen; latter almost reaching distal end of ultimate podomere of antennular peduncle and terminating in corneous, acute, upturned tip; upper surface concave and bearing small setiferous punctations. Subrostral ridges moderately well developed and evident in dorsal aspect to marginal tubercles. Postorbital ridges moderately strong, deeply grooved dorsolaterally, and terminating cephalically in acute, corneous tubercles. Suborbital angle strong with acute corneous tip; branchiostegal spine moderately large and with similar tip. Single pair of cervical spines present; hepatic area and lateral portion of branchiostegites tuberculate; dorsal portion of carapace punctate.

Abdomen shorter than carapace (50.0 and 53.4 mm); pleura of moderate length with caudoventral extremity subangular. Cephalic section of telson with 2 spines in each caudolateral corner. Proximal podomere of uropod with small distal spine on lateral lobe and slightly

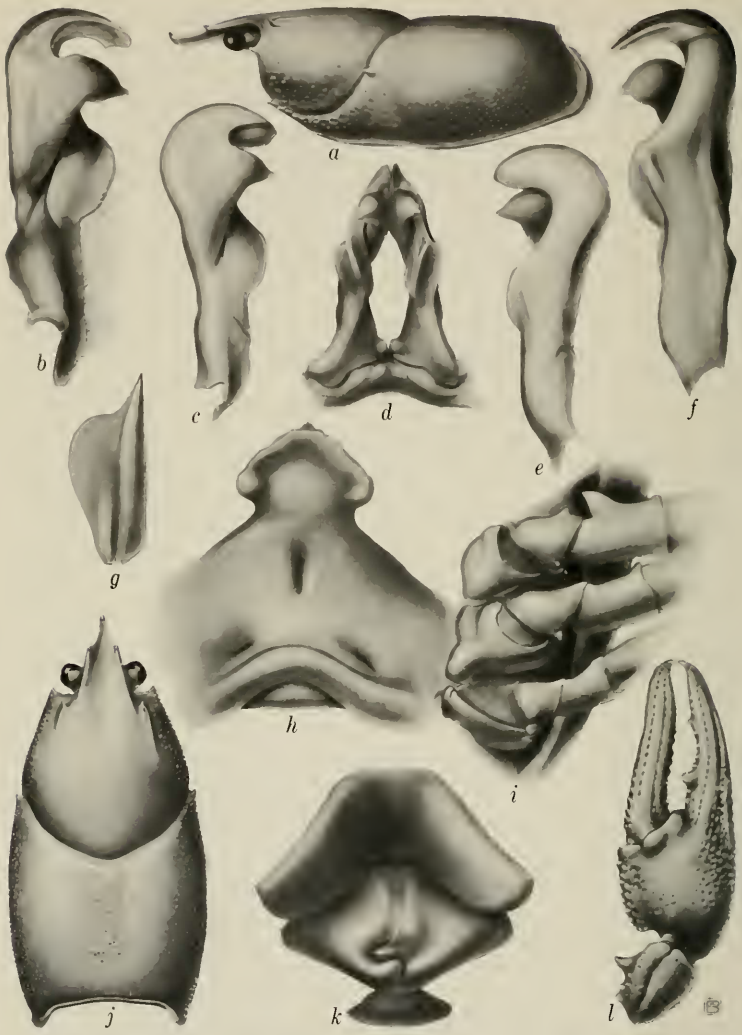

FIG. 1. *Cambarus* (*Puncticambarus*) *cumberlandensis*, new species. *a*, Lateral view of carapace of holotype; *b*, Mesial view of first pleopod of paratypic male, form I; *c*, Mesial view of first pleopod of morphotypic male; *d*, Caudal view of first pleopods of holotype; *e*, Lateral view of first pleopod of morphotypic male; *f*, Lateral view of first pleopod of paratypic male, form I; *g*, Antennal scale of holotype; *h*, Epistome of holotype; *i*, Proximal podomeres of third through fifth pereiopods of holotype; *j*, Dorsal view of carapace of holotype; *k*, Annulus ventralis and adjacent sternal area of allotype; *l*, Dorsal view of distal podomeres of cheliped of paratypic male, form I.

larger one on mesial lobe; both rami with weak longitudinal keel, that on mesial ramus with well-developed premarginal spine.

Cephalic lobe of epistome (Fig. 1*h*) subtriangular with slightly irregular, thickened cephalolateral margins and with weak rounded cephalomedian projection; ventral surface shallowly concave with scattered setiferous punctations. Basal portion of epistome with deep median fovea and pair of obliquely disposed slitlike fossae immediately cephalic and subparallel to thickened, arched epistomal zygoma (Bouchard, 1973); lateral extremities with 1 (left) or 2 (right) tubercles. Proximal segment of antennule with small spine on ventral surface at base of distal third. Antennae extending caudally to sixth abdominal tergum. Antennal scale (Fig. 1*g*) moderately broad, broadest slightly distal to midlength; thickened lateral portion terminating in prominent, acute, corneous-tipped spine projecting forward to about same level as tip of rostrum. Postaxial surface of third maxilliped with submarginal lateral row of short plumose setae, conspicuous submesial longitudinal band of long stiff setae, and small, widely spaced setiferous punctations between longitudinal series.

Left chela (Fig. 1*l*, illustrated in mirrored image) about 3 times longer than broad (56.9 and 21.5 mm), somewhat depressed, although inflated proximolaterally; mesial margin of palm with 2 rows of 7 or 8 tubercles and few additional ones on dorsal surface lateral to rows; distoventral surface of palm with 2 large, swollen tubercles at base of dactyl, lateral one with small, corneous, acute tip. Lateral surface of propodus strongly costate with row of punctations rendering proximolateral margin of fixed finger irregular in dorsal aspect. Fixed finger with proximolateral base deeply impressed dorsally and ventrally; dorsal and ventral surfaces with distinct submedian ridge flanked by setiferous punctations; opposable surface with row of 11 knoblike tubercles along proximal four-fifths of finger, third from base much larger than others, and those along distal three-fourths of finger decreasing in size distally; additional large tubercle present on lower level between sixth and seventh tubercle of row, and double row of minute denticles extending distally from latter-mentioned large tubercle to corneous tip of finger. Dorsal and ventral surfaces of dactyl with median longitudinal ridges, somewhat weaker than those on fixed finger, flanked by setiferous punctations; opposable margin with row of 16 tubercles which, except fourth from base, decreasing in size distally; mesial margin of dactyl tuberculate along proximal half and punctate along distal half; single row of minute denticles extending distally from fourth tubercle to fourteenth, although interrupted by tubercles, and continuing ventrally to corneous tip of finger.

Carpus longer than broad (17.1 and 11.8 mm) with deep oblique furrow dorsally; mesial surface with large procurved spine near midlength and 2 small tubercles on dorsomesial surface of proximal half; distoventral margin with median strong spiniform tubercle and smaller one proximomesial to latter; podomere otherwise punctate.

Upper surface of merus with 2 prominent spines and 1 or 2 small tubercles near distal end; mesial surface somewhat rugose; lateral surface smooth with few fine punctations; ventral surface with lateral row of 7 tubercles, irregular in size and some corneous-tipped, and mesial row of 12 corneous-tipped, acute tubercles; small corneous tubercle also present slightly proximoventral to lateral articulation with propodus. Ischium with row of 5 small tubercles on mesial margin.

Hooks on ischia of third pereiopods only (Fig. 1*i*); hooks simple, overreaching basioischial articulation and opposed by acute tubercle on basis. Coxae of fourth pereiopods with prominent caudomesial boss, those of fifth pereiopods without prominences. For measurements see Table 1.

First pleopods (Fig. 1*b*, *d*, *f*) reaching caudal portion of coxae of third pereiopods when abdomen flexed. See Diagnosis for description.

Allotypic female: Differing from holotype in following respects: acumen of rostrum reaching slightly beyond base of distal podomere of antennule; spine on antennal scale reaching short distance beyond distal podomere of antennule; cephalolateral margins of epistome more regular; more lateral row of tubercles on mesial margin of palm of right chela consisting of 9, in addition, row of 6 tubercles extending proximally from dorsal articular knob at base of dactyl; opposable margin of fixed finger of chela with row of 12 tubercles and cluster of plumose setae at mesioventral base; lateromesial and ventromesial rows of tubercles on merus consisting of 7 and 11, respectively. See Table 1.

Annulus ventralis (Fig. 1*k*) subquadrangular, broader than long, and situated rather shallowly in sternum with cephalic portion fused with sternum and caudal third hinged (slightly movable); cephalic half more pliable than caudal half and bearing median longitudinal trough flanked by subparallel longitudinal ridges; dextral ridge continuing caudally and resembling inverted "?"; sinistral ridge terminating at cephalic base of dextrally directed tongue; sinus originating slightly dextral to median line near midlength of tongue, paralleling contour of curved portion of "?," and finally turning slightly caudodextrad, ending on midcaudal wall of annulus. Sclerite immediately caudal to annulus subspindle-shaped in outline with ventral surface somewhat elevated. Uniramous first pleopods reaching midlength of annulus when abdomen flexed.

Morphotypic male, form II: Differing from holotype in following respects: cephalolateral margins of epistome with 4 asymmetrically arranged tubercles on each side; opposable margin of fixed finger of right chela with row of 10 tubercles, that of dactyl with 15; mesial surface of carpus with additional small tubercle slightly distal to base of procurved spine, and ventromesial surface with additional small tubercle ventral to small distal one on mesial surface; merus with 13 spines in ventromesial row; mesial margin of ischium of cheliped with only 3. Hooks on ischia of third pereiopods much reduced, not reaching basioischial articulation, and opposing tubercle on basis also much smaller;

boss on coxae of fourth pereiopods somewhat smaller and less sharply defined. First pleopods (Fig. 1*c*, *e*) of uniform texture and as illustrated.

Type-locality: Poplar Cove Creek (a tributary to the East Fork of the Obey River), 5.8 miles west of Jamestown, Fentress County, Tennessee, off State Route 52, just east of Helena. There this crayfish was associated with *Orconectes placidus* (Hagen, 1870), *Cambarus* (*Depressicambarus*) *striatus* Hay, 1902c, and *Cambarus* (*Erebicambarus*) *rusticiformis* Rhoades, 1944.

Disposition of types: The holotypic male, form I (no. 132989), the allotypic female (no. 132990), and the morphotypic male, form II (no. 132991) are deposited in the National Museum of Natural History, Smithsonian Institution. Paratypes consisting of 4 ♂ I, 15 ♂ II, 15 ♀, 3 juv. ♂, and 5 juv. ♀ are in the Smithsonian Institution, and 8 ♂ I, 12 ♂ II, 18 ♀, 6 juv. ♂, 7 juv. ♀, and 3 ovigerous females are in the collection of the junior author.

Range: This crayfish is a common inhabitant of the Cumberland River system from Jellico Creek (Scott County, Tennessee) downstream to and including Roaring River in Jackson County, Tennessee (Fig. 2). Nearby populations in the Green River system in Adair and Metcalf counties, Kentucky, perhaps reached this watershed through stream capture or by migrating across low divides; however, a single record from Sink Creek at Tennessee Route 56 in the Caney Fork River system in DeKalb County, Tennessee (not shown in Fig. 2), probably represents an introduction. Such a conclusion is based on the fact that in the many collections made in the Caney Fork River, this crayfish has been found in only the one locality.

Variations: Minor variations are rampant in this species; however, many of the differences noted are obviously due to regenerated appendages and abrasions of spines and tubercles of individuals in late intermolt stages. Of possible phylogenetic interest is the occasional presence of 2 pairs of cervical spines instead of the usual single pair, one or both of which rarely are reduced to tubercles. There is considerable variation in the arrangement of tubercles along the mesial margin of the palm of the chela; whereas usually there are 2 well-defined rows with a few irregularly arranged above and below them, in some individuals there are 3 somewhat distinct, although irregular, rows. Rhoades, 1944:136, pointed out that his specimens from Beaver Creek (Wayne County, Kentucky) possess only a single row of tubercles along the mesial margin of the palm. In our 6 specimens from the same stream, all have 2 rows, and we have observed no specimens from elsewhere with fewer than 2 rows.

The limited material available from the Green River drainage is indistinguishable from most of that from the Cumberland system.

Comments on Ortmann's discussion (1931:102) of the specimens from "the upper Cumberland drainage" seem hardly apropos, for *C. girardianus* is, in our opinion, a somewhat distantly related species that has been assigned to the subgenus *Hiaticambarus* (Hobbs, 1969:106).

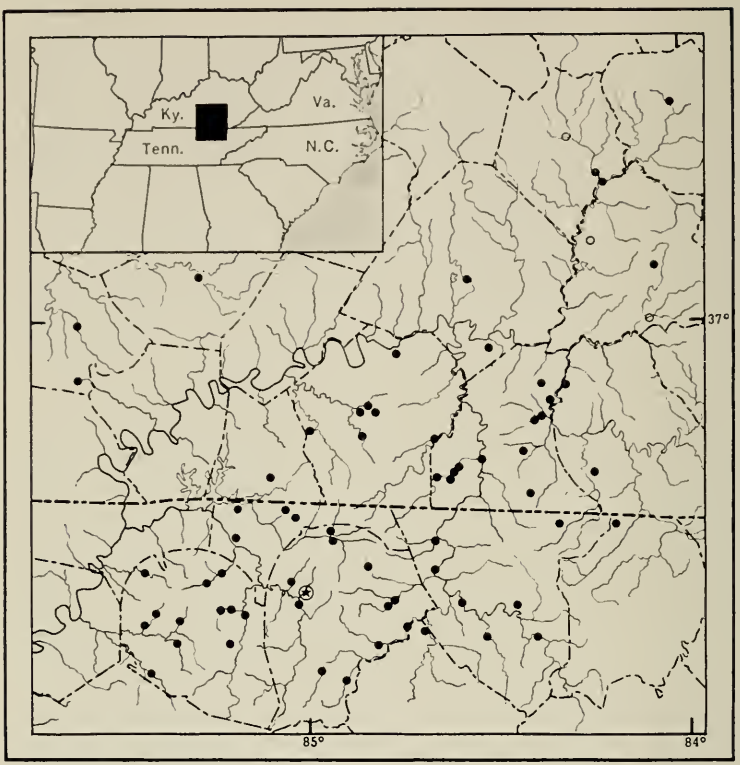

Fig. 2. Distribution of *Cambarus* (*P.*) *cumberlandensis*. One locality in the Caney Fork River drainage is not included, see "Range." Encircled star = type-locality; open circles = specimens not seen by us, records based on Rhoades, 1944.

Size: The largest specimen available is a second form male with a carapace length of 57.4 mm (postorbital length 46.6 mm). The smallest first form male has corresponding lengths of 43.6 and 33.8 mm. The largest first form male has a postorbital length of 46.0 mm (rostrum broken). The smallest female with eggs (or young) has a carapace length of 39.3 mm (postorbital length of 30.1 mm).

Color notes: Ground color of cephalothorax and abdomen ranging from blue green, green, greenish brown to brown dorsally, usually concolorous although sometimes mottled in juveniles. Dorsal dark brown band with cephalomedian emargination situated immediately anterior to cervical groove; narrower similar bands present on caudal margins of carapace and abdominal terga. Gastric area with caudolateral subelliptical patches of dark vermiculations marking attachments of mandibu-

lar muscles. Branchiostegites and hepatic region fading ventrally to cream or white, occasionally mottled; areola frequently lighter in color than adjacent portions of branchiostegites. Rostral margins and postorbital ridges varying from light brown or orange to cream; cervical spines and tubercles on carapace ranging from orange or yellow to cream. Dorsum of abdomen fading or becoming darker laterally; pleura of first abdominal segment with or without cream spot. Terga with somewhat regular dorsolateral greenish to light brown pattern consisting of circles with attached stems directed cephalically, and with conspicuous semilunar markings at bases of pleura. Ventral surface of cephalothorax and abdomen cream to white. Flagella of antennules and antennae and lateral margin of antennal scale dark green to brown; peduncles and remainder of scale mostly cream mottled with green or brown. Chelae with ground color of dorsal surface corresponding to that of cephalothorax but profusely modified by dark green to dark brown reticulations and larger spots; tubercles and lateral costa orange to cream, and both fingers fading distally to yellow, sometimes with yellow coloration extending proximally to midlength of fingers; dorsal surface of merus and carpus of cheliped colored similar to palmar area of chela but with dark brown reticulations more restricted. Remaining pereiopods with merus through propodus usually similarly colored dorsally, although hues less intense; dactyl, entire proximal podomeres, and ventral surfaces of all pereiopods cream to white.

Life history notes: Collections have been made during January and April through November. First form males were found from April to November. Ovigerous females have been observed during July, August, and September, and a female with young was collected on 15 August 1969. Rhoades (1944:136) reported a female "bearing 'eyed' eggs" collected on 15 August 1939.

Ecological notes: *Cambarus cumberlandensis* occurs under rocks and among debris in streams ranging from a few feet in width to large rivers. In broader streams, the large individuals are more common in the middle portion of the stream, and, sharing that area of the stream with members of the genus *Orconectes*, is predominant under the larger rocks. With the exception of *Cambarus rusticiformis*, other sympatric congeners are typically more abundant near shore.

Accompanying *Cambarus cumberlandensis* in at least parts of its range are *Cambarus* (*Jugicambarus*) *distans* Rhoades, 1944; *C.* (*J.*) *parvoculus* Hobbs and Shoup, 1947; *C.* (*J.*) new species Bouchard (in press); *C.* (*Depressicambarus*) *striatus* Hay, 1902c; *C.* (*D.*) *sphenoides* Hobbs, 1968a; *C.* (*Erebicambarus*) *rusticiformis* Rhoades, 1944; *C.* (*E.*) *tenebrosus* Hay, 1902b; *Orconectes placidus* (Hagen, 1870); and two additional undescribed members of the latter genus.

Relationships: *Cambarus* (*P.*) *cumberlandensis* is more closely allied to *Cambarus extraneus* Hagen, 1870, than to any other crayfish. Both share with *C. nerterius* Hobbs, 1964, *C. spicatus* Hobbs, 1956, and an undescribed species of the subgenus *Puncticambarus*, marginal spines

or tubercles on the rostrum, all differing in this respect from other members of *Puncticambarus*. *Cambarus spicatus* is unique among them in that it possesses hepatic spines. *Cambarus nerterius* differs from *C. cumberlandensis* and *C. extraneus* in having only 1 row of tubercles along the mesial margin of the palm of the chela and in having 2, instead of 1, rows of tubercles along the opposable margins of the fingers. The differences that exist between *C. cumberlandensis* and *C. extraneus* include the absence of stripes in the former as compared with the conspicuous longitudinally striped cephalothorax and abdomen of the latter. In *C. cumberlandensis* the impressions at the base of the fixed finger of the chela are distinctly deep whereas in *C. extraneus* they are very shallow, that on the ventral surface forming only a shallow concavity even in the largest males. The suborbital angle of the former is typically acute or subacute whereas that of the latter is obtuse although often furnished with a small acute spine. Although the characters of the areola overlap in the 2 species, in general that of *C. extraneus* is less than 4 times longer than broad (range 3.1–4.8, average 3.4); it is more often greater than 4 times longer than broad in *C. cumberlandensis* (range 3.5–5.3, average 4.4); also in *C. extraneus* it never constitutes more than 33.4 percent of the total length of the carapace (range 31.0–33.4, average 32.3) and 42.5 percent of the postorbital length (range 41.3–42.5, average 41.7); in *C. cumberlandensis* the respective ranges are 31.6–37.3, average 34.5, and 41.6–46.1, average 43.7, percent. Measurements of juvenile specimens are not included in these percentages.

TABLE 1. Measurements (mm) of *Cambarus* (*Puncticambarus*) *cumberlandensis*

	Holotype	Allotype	Morphotype
Carapace			
Height	18.5	16.2	15.1
Width	27.9	21.4	21.8
Total length	53.4	42.1	42.7
Postorbital length	42.5	33.9	34.0
Areola			
Width	4.0	3.6	3.2
Length	19.0	15.0	15.2
Rostrum			
Width	7.9	6.0	6.4
Length	13.4	10.3	10.6
Chela			
Length of mesial margin of palm	16.4	10.4	9.6
Width of palm	21.5	13.7	13.2
Length of lateral margin	56.9	35.2	35.8
Length of dactyl	37.5	21.7	23.5

Cambarus (*Jugicambarus*) *carolinus* (Erichson)

Astacus Carolinus Erichson, 1846:87, 88.—Hagen, 1870:6.

Astacus (*Cambarus*) *Carolinus* Erichson, 1846:96–97.

Astacus (*Cambarus*) *carolinus*.—Dana, 1852:522 (by implication).—Ortmann, 1906:394.—Fowler, 1912:567.—Ortmann, 1931:147.

Cambarus carolinus.—Girard, 1852:88.—Hay, 1899:959, 962; 1902a:38*.—Harris, 1903:58, 81, 96*, 142, 154*, 158*.—Ortmann, 1905b:122*, 123*, 128*, 129*; 1905c:393*–395*, 398*, 401*; 1906:394, 451*–453*.—Fowler, 1912:567*.—Ortmann, 1913:333*(?).—Faxon, 1914: 396*, 397*, 398, 399*, 425.—Ortmann, 1931:156, 157*(?).—?Creaser, 1934:364.—?Brimley, 1938:503*.—Hobbs, 1942a:335; 1942b:75, 165.—Rhoades, 1944:146.—?Griffith, 1945:269.—Pennak, 1953:456*, 464*.—Penn, 1955:73.—Hobbs, 1959:897*.—Hobbs III, 1965:163.—Hobbs, 1967:126, 130; 1968b:K-15*; 1970:168.—Hobbs & Walton, 1970:860.

Cambarus Carolinus.—Hagen, 1870:6, 8.—Faxon, 1884:140*, 141*; 1885:11, 54*, 58*, 65*, 158*, 167*, 173*.—Underwood, 1886:366, 368.

Cambarus (*Bartonius*) *carolinus*.—Ortmann, 1905b:120*; 1906:394*, 397*.

Cambarus (*Cambarus*) *carolinus*.—Fowler, 1912:341 (by implication).—Ortmann, 1931:147*, 149*–152*, 155(?).

Cambarus carolinus carolinus.—Faxon, 1914:399.—Ortmann, 1931: 150*(?).

Cambarus carolinensis.—Rhoades, 1944:147 (erroneous spelling).

Cambarus (*Jugicambarus*) *carolinus*.—Hobbs, 1969:107*, 108*, 139*, 142*–144*, Figs. 9*, 19a.

This crayfish was described by Erichson (1846) who based his brief account of it on a single first form male collected "In Carolina in Nordamerika von Hrn. Cabanis aufgefunden." Among the characters mentioned, the narrow areola and a single cristiform row of tubercles on the palm of the chela can apply only to one crayfish in the region of the type-locality—the latter subsequently more precisely determined through the efforts of Hagen (see Faxon, 1885:9).

The next reference to the species was that of Girard (1852) who elevated Erichson's subgenus to generic rank, referring to the crayfish as *Cambarus carolinus*, and cited the localities, "Carolina (Erichson); Anderson, S. C." There is no explanation for his including Anderson as a locality for the species, and it has not been repeated subsequently. Although Girard included *Astacus affinis* Milne Edwards, 1837 (not Say, 1817), in his synonymy of *C. carolinus*, it is very unlikely that Milne Edwards was referring to Erichson's species.

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* In part.

In the same year, Dana (1852) refuted Girard's elevation of Erichson's subgenus *Cambarus* to generic status and, by implication, referred to this crayfish in the original combination.

Hagen (1870), in monographing the North American crayfishes, misapplied the name *C. Carolinus* to an undescribed species, later designated *Procambarus hagenianus* (Faxon, 1884), and made the further error of transposing his treatment of it together with some of the illustrations with those of *P. advena* (LeConte, 1856). Only the references on pages 6 and 8 apply to Erichson's species.

Faxon (1884) discussed the confusion in Hagen's treatment of *C. carolinus* and indicated that the latter had examined Erichson's type in 1870 and "thought that it was *C. Bartonii*." Faxon concluded that "if it [Hagen's *C. Carolinus*] be really *C. Bartonii*, the species under consideration must receive a new name, *C. Hagenianus*." The fact that Hagen, after examining the male type, thought it conspecific with *C. bartonii* almost certainly testifies to the conclusion that the first pleopod of Erichson's species ended in two parts recurved at approximately 90 degrees to the main shaft of the appendage, thus associating it with the currently recognized genus *Cambarus*, s.s. Moreover, Faxon's proposal of the provisional name *C. hagenianus* for Hagen's intended *C. carolinus* was obviously justified. In 1885, he enlarged upon the discussion presented in 1884, but in spite of Hagen's remark concerning the type, he was apparently uncertain as to which of his "Groups" Erichson's species should be assigned. The most important contribution was the statement (p. 9) that Dr. Cabanis informed Dr. Hagen "that all the Cambari which he collected were taken in a rivulet in the northern part of South Carolina, near Greenville, at a farm called Tiger Hall."

Underwood (1886) added nothing to our knowledge of the species and erroneously (p. 386) ascribed the description of *C. carolinus* to Hagen, 1870.

The key to the North American crayfishes by Hay (1899) failed to contribute to the recognition of the species. Laying the groundwork for further problems, Faxon (1890) cited a specimen, which he assigned to his *C. dubius* (1884), from " 'Among the Cherokees,' Indian Territory" (this was corrected by him (1914:396): "it was in reality obtained in Swain or in Jackson Co., N.C., among the *Eastern* Cherokees . . ."). Inasmuch as *C. dubius* was synonymized with *C. carolinus* by Hay (1902a), Faxon's 1890 citation entered the literature of *C. carolinus* and caused further uncertainties regarding the range of the species. Ortmann's (1902) discussion of *C. carolinus* was based upon Hagen's error in applying the name to the undescribed *P. hagenianus*, and therefore augmented the existing errors.

Hay (1902a), after obtaining a photograph of Erichson's type and drawings of the first pleopod and chela, stated "They show that the species [*C. carolinus* (Erichson)] is neither *C. carolinus* Hagen nor *C. bartonii* Fabricius, but *C. dubius* Faxon." Even though in our opinion

the positive portion of this statement is in error, the fact that Hay believed *C. dubius* to be synonym of *C. carolinus* assures us that Erichson's type was not a member of the currently recognized genus *Procambarus* (thus disassociating it with *P. hagenianus*), and it became clear that it belongs to the species group currently recognized as the subgenus *Jugicambarus*. Unfortunately, Hay stated that Erichson's type was collected in western North Carolina, an error that was accepted and expanded upon by Harris the following year. The West Virginia localities mentioned by Hay are referable to *C. dubius* rather than to *C. carolinus*.

Harris (1903) abetted the existing chaos surrounding the identity and range of *C. carolinus* when he compiled and made cross references to erroneous locality records from the literature; in so doing he compounded the mistakes by reporting the occurrence of this crayfish in spurious drainage systems.

Ortmann (1905b) utilized a new combination, *Cambarus* (*Bartonius*) *carolinus*, and, considering *C. dubius* a synonym, cited a range for the species that considerably exceeds the limits as determined by the localities included herein. In the same year (1905c), he recorded new locality records and observations on the habits of *C. dubius*, again designated by him as *C. carolinus*. His classical treatment of the crayfishes of Pennsylvania (1906) adds almost nothing to our knowledge of Erichson's species but is the best account available for *C. dubius*.

Fowler (1912) corrected Ortmann's subgeneric designation, *Bartonius*, and implied a new combination for this species, *Cambarus* (*Cambarus*) *carolinus*. The following year, Ortmann (1913) simply referred to this crayfish as a burrowing species.

Faxon (1914), in addition to summarizing the locality records and reviewing some of the complexities of the literature devoted to this species, introduced the combination *Cambarus carolinus carolinus*, recognizing 2 additional subspecies, *C. carolinus dubius* and *C. carolinus monongalensis* Ortmann, 1905c.

Ortmann (1931) reviewed the status and ranges of *C. carolinus* and its close relatives, considering *C. dubius* a synonym of *C. carolinus* and maintaining specific rank for his *C. monongalensis*. Except for 2 possible new localities ("Swampy ground near springs, Marion, McDowell County, North Carolina" and "Swamp, Ashville, Buncombe Co., North Carolina") which should be confirmed, he added nothing to our knowledge of the species as restricted here. All other localities cited are for *C. dubius* or undescribed relatives.

Creaser (1934) referred to the color of the burrowing *C. carolinus* as being red. Although it is typically red, this information was almost certainly gleaned from observations of previous authors on *C. dubius* who considered it a synonym of *C. carolinus*. Brimley (1938) listed the North Carolina records cited by Ortmann (1931) and included an additional one, "Judson." This locality also should be confirmed.

All except one of the citations to *Cambarus carolinus* by Fleming

(1938–1939) refer to *C. gentryi* Hobbs, 1970; the record from Cumberland Gap, Claiborne County, Tennessee, refers to *C. dubius* or a probable undescribed species.

Hobbs (1942a and b) added no new information, and Rhoades (1944) included nothing more than an indication that *C. carolinus* would probably be found in Kentucky. Griffith (1945) recorded the presence of corixid eggs on this crayfish; however, his failure to cite a locality and the general lack of understanding as to the identity of this species leave doubt as to the authenticity of the determination.

With the following exception, all of the references noted in the synonymy after 1945 include statements concerning relationships of other crayfishes to *C. carolinus* or to its serving as a host to entocytherid ostracods or branchiobdellids. Hobbs (1969) introduced the combination *Cambarus* (*Jugicambarus*) *carolinus* and presented the only illustration available of Erichson's *C. carolinus*.

The many other references to this species that are not included in the above synonymy are presented below.

To summarize our knowledge of Erichson's *C. carolinus*—until 1969, all that was known about it was that it is a member of the genus *Cambarus* closely allied to members of the species group now constituting the subgenus *Jugicambarus*, that it occurs in the vicinity of Greenville, South Carolina, and that it possesses, among the few characters mentioned by Erichson, a narrow areola and a chela bearing a single cristiform row of tubercles along the mesial margin of the palm. In view of the fact that the type has been lost, it is unfortunate that neither Hay nor Faxon published the photograph and drawings of it that were examined by both of them.

After collecting crayfishes in the vicinity of Greenville on a number of occasions between 1934 and 1968, one of us (Hobbs) became convinced that the only species occurring in the area that possesses the 2 characters just cited is that which he illustrated in his summary of the genus (1969) and which is described and more fully depicted below. Hence, except for the single figure of the first pleopod that was included in Hobbs' 1969 publication, the only unquestionable published data available on the species is that pertaining to Erichson's type.

For a number of years, Hobbs has attempted to discover the location of "Tiger Hall" farm without success. Several collecting trips in the Greenville area were made and he and companions finally secured several specimens of *C. carolinus* from a single locality in the Saluda watershed (see Specimens Examined). Not until recently, when Mr. George F. Townes of Greenville, South Carolina, became interested in the problem, was any progress made in finding the locality at which Erichson's specimen was collected. Mr. Townes communicated the following to us:

"I interpret the locality phrase 'Tiger Hall Farm,' as referring to a Hall farm on the Tyger River. This river is ordinarily spelled 'Tyger' rather than 'Tiger.' This would be analogous to 'Potomac, Smith Farm.'

"Plantations were customarily not named in upper South Carolina . . . I assume rather that the collector was interested in recording first the river, then the location on the river.

"I find that in 1804 Baylis Earle conveyed 182 acres on the South Tyger River to Joab Hall. The deed description refers to the property as being located on Wildcat Creek, waters of South Tyger River. The deed is recorded in Deed Book G, at page 153 . . .

"There are no deeds of record by Joab Hall and no record of his estate. There is nothing to show that he did not own the farm in 1846. I do not find any other deeds conveying property on the Tyger River to anyone named Hall in the early 19th Century."

With this probable identification of the type-locality, we went to Greenville, and, with the assistance of Mr. John J. Huebner of the Greenville County Planning Commission, located Wildcat Creek (labeled "Camp Creek" on a 1952 edition of the General Highway Map of Greenville County) and a farm nearby known locally as the "old Hall farm." Specimens that are surely Erichson's *Cambarus carolinus* were obtained from burrows in both localities which are less than 3 miles apart (see Specimens Examined) and on small tributaries of the South Tyger River. Inasmuch as the farm that was deeded to Joab Hall was stated to be located on Wildcat Creek, we shall consider those specimens collected by us from along this stream as topotypes of the species. Furthermore, there is every reason to believe that all of the specimens cited below are conspecific. The second form male topotypes are being maintained in aquaria in anticipation of their molting to the first form.

Diagnosis: Body and eyes with pigment; latter conspicuously small. Rostrum slightly broader than long, without marginal spines or tubercles. Areola 13.7 to 39.3 times longer than broad and constituting 37.3 to 40.7 percent of total length of carapace (42.5 to 46.0 percent of post-orbital length) with 1 punctation in narrowest part. Cervical spines absent, tubercle representing it scarcely larger than others nearby; hepatic spines lacking; suborbital angle virtually obsolete; postorbital ridge strong but without spine or tubercle cephalically; branchiostegal spine low and tuberculiform. Antennal scale approximately 2.5 times longer than broad, margins subparallel proximal and distal to midlength. Chela with single cristiform row of 6 to 8 tubercles on mesial surface of palm, lateral margin weakly costate, particularly proximally; dactyl less than twice length of mesial margin of palm. Hook on ischium of third pereiopod overreaching basioischial articulation and not opposed by tubercle on basis. First pleopod of first form male with central projection corneous, bladelike, lacking subapical notch, recurved at angle of approximately 110 degrees, and constituting, if straightened, almost one-fourth total length of appendage; mesial process tumescent basally with cephalodistal surface tapering strongly to subacute tip of process and directed caudolaterally at angle of 90 degrees to main axis of appendage. Annulus ventralis strongly asymmetrical, broader than long;

FIG. 3. *Cambarus* (*Jugicambarus*) *carolinus* (Erichson), male, form I. (USNM no. 116930). Right chela in specimen is regenerated, that figured is mirrored image of left chela.

cephalic half bearing median longitudinal trough flanked by caudally diverging longitudinal ridges which, near midlength of annulus, joining arched transverse ridges; dextral fused ridge continuing caudosinistrally across median line and forking into subtransverse tongue disappearing under sinistral wall and sinuous dextral wall of sinus; sinistral fused ridge heavier than dextral and forming high J-shaped sinistrocaudal wall of annulus; sinus in form of almost inverted S. First pleopods of female moderately well developed, reaching midlength of annulus when abdomen flexed.

Male, form I (U.S.N.M. no. 116930): Body subcylindrical (Figs. 3, 4*a*). Abdomen narrower than thorax (13.6 and 17.3 mm). Greatest width of carapace greater than depth at caudodorsal margin of cervical groove (17.3 and 14.0 mm). Areola 18.3 times longer than wide with 1 or 2 punctations in narrowest part; length of areola approximately 40.0 percent of entire length of carapace (46.0 percent of postorbital length). Rostrum broken but with only slightly thickened convergent margins lacking spines or tubercles; surface concave with widely spaced punctations, somewhat concentrated at caudomesial bases of margins. Subrostral ridges weakly developed. Postorbital ridges rather depressed with deep longitudinal dorsolateral furrows and merging almost imperceptibly with carapace cephalically. Suborbital angle very weakly indicated, almost obsolete; branchiostegal spine reduced to small angular tubercle. Cervical spine represented by tubercle subequal in size to others in vicinity; hepatic area and lateral portion of branchiostegites tuberculate; gastric area polished with very few small tubercles in cephalomedian and cephalolateral areas, remainder of dorsum punctate.

Abdomen shorter than carapace (26.5 and 36.0 mm); pleura moderately short and rounded ventrally. Cephalic section of telson with single spine in each caudolateral corner. Proximal podomere of uropod with mesial lobe bearing minute acute tubercle, lateral lobe unarmed; mesial ramus with moderately strong submedian keel terminating in premarginal spine.

Cephalic lobe of epistome (Fig. 4*i*) subhemispherical in outline with cephalomedian projection and 2 cephalolateral pairs of low subtriangular projections, its ventral surface with pair of anterior tubercles and paired horizontal rows of punctations; basal portion with well-developed fovea and arched epistomal zygoma; lateral extremities without tuberosities. Proximal segment of antennule with small spine at base of distal third. Antennae extending caudally to first abdominal tergum. Antennal scale (Fig. 4*d*) short and moderately broad, with mesial and lateral margins subparallel for some distance proximal and distal to midlength; thickened lateral portion terminating in prominent, somewhat distolaterally directed, corneous-tipped spine projecting forward to base of ultimate podomere of antennule. Postaxial surface of third maxilliped with submarginal lateral row of short plumose setae and clusters of simple, erect setae arranged in 2 submedian longitudinal rows, most tufts with few plumose setae.

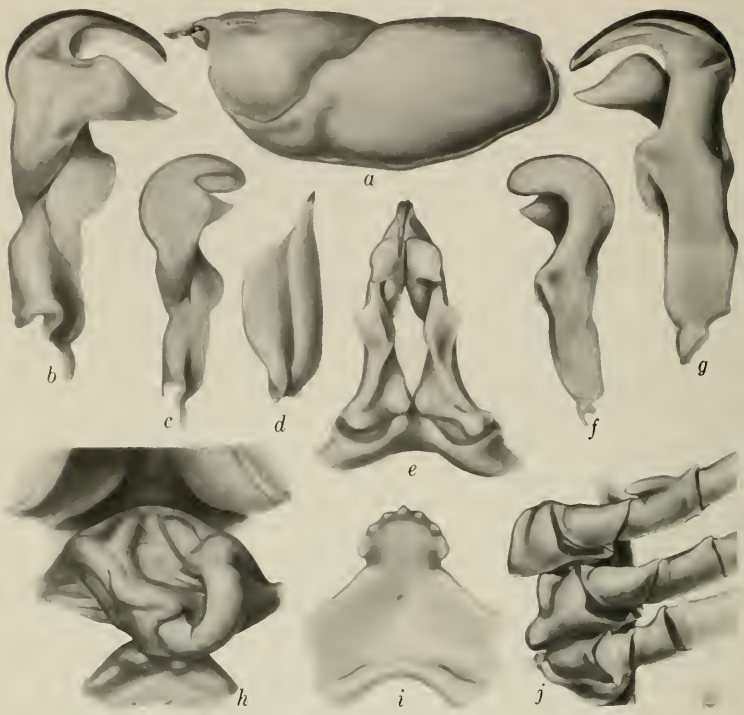

Fig. 4. *Cambarus* (*Jugicambarus*) *carolinus* (Erichson). *a*, Lateral view of carapace of male, form I; *b*, Mesial view of first pleopod of same; *c*, Mesial view of first pleopod of male, form II; *d*, Antennal scale of male, form I; *e*, Caudal view of first pleopods of male, form I; *f*, Lateral view of first pleopod of male, form II; *g*, Lateral view of first pleopod of male, form I; *h*, Annulus ventralis and adjacent sternal area of female; *i*, Epistome of male, form I; *j*, Proximal podomeres of third through fifth pereiopods of male, form I.

Left chela (Fig. 3) about 2 times longer than broad (26.4 and 12.8 mm), rather depressed, and with gaping fingers; mesial margin of palm with single cristiform row of 7 tubercles (counting that on distal border); dorsal surface of palm punctate with conspicuous row of deep punctations extending proximally from articular notch at base of dactyl; lateral margin of palm with longitudinal series of punctations and weakly costate distally; ventral surface of palm with small shallow punctations mesially, large deep ones on lateral half, and 3 prominent tubercles: one on distal margin near mesial base of dactyl, another proximomesial to first, and third proximal to distal ridge and slightly lateral to latter tubercle.

Fixed finger with prominent submedian longitudinal ridge dorsally and slightly weaker more mesial ridge, both flanked by setiferous punctations; lateral margin slightly costate with single row of similar punctations; ventral surface with single longitudinal ridge displaced somewhat mesially; opposable surface with 2 prominent tubercles in proximal third, another on lower level at base of distal fourth, and single row of minute denticles extending distally from second basal tubercle to corneous tip of finger, row broken only by distalmost tubercle. Dorsal and ventral surfaces of dactyl similar to those of fixed finger except ventral ridge submedian. Mesial surface with 2 rounded tubercles at base and single longitudinal row of setiferous punctations extending to corneous tip of finger; opposable margin with row of 6 tubercles along proximal four-fifths of finger and single row of minute denticles extending distally from fourth tubercle to corneous tip of finger.

Carpus longer than broad (11.2 and 9.0 mm) with prominent oblique furrow dorsally; mesial surface with large, spikelike, procurved tubercle, smaller but similar one proximally, and much smaller one dorsal to level of 2 large tubercles; ventral surface with mesial arc of 3 tubercles and small one at base of second; ventral laterodistal angle with tuberculiform swelling on articular boss; podomere otherwise punctate.

Dorsal surface of merus with 3 subdistal rounded tubercles and row of very low ones extending proximally from lateralmost of subdistal group; lateral and mesial surfaces sparsely punctate; ventral surface with lateral row of 3 subacute tubercles and mesial one of 7. Mesial margin of ischium with 4 very small, irregularly arranged tubercles.

Hooks on ischia of third pereiopods only (Fig. 4*j*); hooks simple, overreaching basioischial articulation but not opposed by tubercle on basis. Mesial surface of coxa of second, third, and fourth pereiopods with prominent flange, particularly conspicuous on coxae of third and fourth; coxa of fourth pereiopod with rather large caudomesial boss, that of fifth with only slight caudomesial swelling at caudoventral base of penis papilla.

First pleopods (Fig. 4*b*, *e*, *g*) reaching caudal portion of coxae of third pereiopods when abdomen flexed. See Diagnosis for description.

Female (USNM no. 114096): Rostrum broader than long, extending anteriorly to midlength of penultimate podomere of antennular peduncle, shallowly excavate dorsally, with convergent margins and corneous upturned tip; acumen not delimited basally. Otherwise differing from male, form I, in following respects: cephalolateral margins of epistome evenly rounded, fovea represented by broad shallow depression; ventrolateral surface of fixed finger of right chela with row of long stiff setae; opposable margin of fixed finger with row of 4 tubercles on proximal half, third from base largest, and that of dactyl with 8 along proximal five-sixths; mesial surface of carpus with small dorsal tubercle lacking, and ventral surface without small tubercle at base of second tubercle of arc; dorsal surface of merus with only 1 well defined subdistal tubercle,

others vestigial; neither coxae nor ischia of third through fifth pereiopods modified. Annulus ventralis (Fig. 4*h*) deeply imbedded in V-shaped sternum and as described in Diagnosis. Sternite immediately caudal to annulus concavo-convex (concave caudally), elevated ventrally with median cleft.

Male, form II (USNM no. 133056): Differing from first form male in following respects: epistome with cephalolateral margins rounded; cephalic section of telson with 2 spines in each caudolateral corner, mesial members movable; ventral surface of palm of right chela with 1 additional tubercle proximal to major tubercle on distal margin at base of dactyl; all punctations on chela with better developed setae, those flanking tubercles on opposable margins of fingers proportionately much more conspicuous, and those on ventrolateral surface of fixed finger and on ventromesial surface of dactyl quite long and stiff; however, those on dactyl not so long as those on fixed finger; mesial surface of carpus with only 2 spiniform tubercles, smaller ones lacking; ventromesial surface with small tubercle ventral to major spine on mesial surface, and ventral surface without small tubercle at base of second member of arc; ventral surface of merus with lateral and mesial rows of 4 and 6 tubercles, respectively; mesial margin of ischium with only 3 small tubercles. First pleopod (Fig. 4*e*, *f*) of uniform texture; mesial process lacking arch at distal base, shorter and more nearly conical; central projection lobiform and directed at right angle to principal axis of appendage. Remaining secondary sexual characters, except flanges on coxae of second through fourth pereiopods, much reduced in size and less sharply defined.

Specimens Examined: The specimens described and illustrated here were collected from burrows along a small tributary to the Saluda River in a wooded area northwest of Greenville, about 0.5 mile north of State Route 183 on Route 462, Greenville County, South Carolina. The burrows are complex, winding among roots and debris, with several openings to the surface. The deepest passages are not more than 2.0 feet deep. Situated along the low banks of the small brook, where the water table is almost at the surface, the entire burrows are water-filled, and, at the times this locality was visited, none of the openings was marked by well-formed chimneys. Only 4 specimens were collected at this locality: 1 ♂ II, VI/12/52, H. H. H., coll.; 1 ovigerous ♀, IV/14/62, J. F. Fitzpatrick, Jr., and H. H. H.; 1 ♂ I, 1 ♀, IV/16/66, J. F. Payne, J. F. F. and H. H. H.

Collections from burrows at 2 additional localities in the Tyger River drainage in Greenville County are also available. Along Wildcat Creek, 8.8 miles north of the junction of U.S. Hwy. 29 and State Route 101, on latter, 3 ♂ II, 1 ♀, and 1 ♀ with young, VI/13/72, D. J. Peters, J. E. Pugh, F. E. Oakberg, C. F. Saylor, R. W. B. and H. H. H. On the same day, these collectors obtained 1 ♂ II, and 4 ♀ along a small creek on County Route 113, 0.5 mile northeast of its intersection with County Route 92, on the Hall farm.

A small female was dug from a burrow along Georges Creek, at the junction of State Routes 135 and 183 in Pickens County, South Carolina, on 24 April 1967, by Rudolph Prins, Torgny Unestam, and H. H. H.

To our knowledge, the 15 crayfish just cited represent the only extant specimens of the species.

Color notes: Carapace mostly brick red dorsally, with gastric area bearing 2 broad, transverse, irregular but symmetrical, darker reddish brown bands fading on hepatic region; lateral portion of branchiostegites fading ventrally to pinkish cream. Cephalic part of first abdominal tergum almost black, its caudal part and remaining terga reddish brown dorsally, fading to pale brick red on pleura; dorsal surface of telson and uropods brownish red, fading toward caudal and distal extremities, respectively. Antennules and antennae mostly dilute brick red, flagellum of latter dark reddish brown. All pereiopods with podomeres distal to ischium red dorsally, fading ventrally; with exception of cheliped, distal portion of merus and dorsum of carpus of each darker than remaining podomeres; proximal portion of merus fading to pinkish cream, matching color of 3 basal podomeres. Cheliped similar to other pereiopods except dorsal surface of palmar area of propodus darker than most of carpus, and ridge flanking dorsal base of dactyl almost black; tubercles on cheliped, as well as elsewhere, distinctly lighter than remaining surfaces, some with almost cream tips. Ventral region of body varying from pinkish cream to cream.

Variations: While none of the variations noted has been correlated with a particular locality, there exist conspicuous differences among the available specimens. One of the most noticeable is in the shape of the rostrum which varies from that illustrated to one in which distinct angles exist at the base of a broad, short acumen. The areola exhibits variations in its relation to the postorbital length and in its relative width; variations in its length are reflected in the ratio, areola length/postorbital length that ranges from 42.5 to 46.0 percent, and in its width by the ratio, areola length/areola width that ranges from 13.7 to 39.3 percent. The cephalic lobe of the epistome usually lacks all of the cephalolateral prominences that are illustrated in Fig. 4*i*. The cephalic section of the telson bears 1 or 2 spines in each caudolateral corner. The number of tubercles on the mesial margin of the palm of the chela ranges from 6 to 8 (as few as 5 in a regenerated chela). Usually, the mesial surface of the carpus of the cheliped has fewer tubercles than that of the first form male: there is a major spine slightly distal to midlength and a less prominent tubercle proximally, and occasionally there is a smaller tubercle at the base of the latter. The number of tubercles on the ventral surface of the merus of the cheliped ranges from 5 to 8 in the mesial row and 3 to 6 in the lateral one, and those on the mesial margin of the ischium from 0 to 4. Mirrored images of the annulus ventralis also exist, and, as usual, in young females the sculpture is not so well developed although the conspicuous cephalomedian depression is always obvious.

TABLE 2. Measurement (mm) of *Cambarus* (*Jugicambarus*) *carolinus*

	Male, Form I	Male, Form II	Female
Carapace			
Height	14.0	15.0	7.3
Width	17.3	19.1	10.0
Total length	36.0*	38.0	20.5
Postorbital length	31.7	33.8	18.0
Areola			
Width	0.8	1.1	0.6
Length	14.6	15.4	8.2
Rostrum			
Width	5.7	6.1	3.3
Length	— *	5.4	3.0
Chela			
Length of mesial margin of palm	9.0	9.2	3.8
Width of palm	12.8	13.4	6.0
Length of lateral margin	26.4	27.1	12.0
Length of dactyl	16.7	17.1	7.4

* Rostrum broken—total length estimated.

Misapplications of the name, Cambarus carolinus: The following synonymies are not complete; instead, they include only the original citation to the species and misidentifications of them as *Cambarus carolinus*.

Cambarus (*Jugicambarus*) *dubius* Faxon

Cambarus dubius Faxon, 1884:114.

Cambarus carolinus.—Hay, 1902a:38*.—Harris, 1903:58*, 59, 81*, 82, 96*, 137*, 146*, 148, 154*, 155, 158*.—Ortmann, 1905b:122*, 123*, 128*, 129*, 136; 1905c:388, 389, 393*, 394*, 395*, 396, 398*, 399, 400, 401*; 1906:346, 349, 351, 401, 403, 404, 414, 416–420, 451*, 452*, 453*, 454, 464–466, 489, 491, 492, 495–497, 500–503, 510–512. —Williamson, 1907:759, 760.—Adams, 1907:897.—Ortmann, 1907: 713–716; 1913:333*(?).—Newcombe, 1929:280–282, 284, 287.—Ortmann, 1931:157*.—Creaser, 1934:364(?).—Pennak, 1953:456*, 464*. —Hobbs, 1959:897*.—Meredith & Schwartz, 1959:2; 1960:21, 24, 28–30, Fig. 12.—Schwartz & Meredith, 1960:42, 54; 1962:260, 261, 271.—Hobbs & Walton, 1962:42, 44.—Hobbs & Hart, 1966:36*, 38*, 39, 40(?), 43, 46.—Hobbs, Holt, & Walton, 1967:5–8, 12, 16, 17, 22–25, 36, 38, 41, 51, 54, 58, 61, 64–70, 72, 74, 75, 78, Fig. 3.— Browning, 1968:3.—Hobbs, 1968b:K-15*.—Momot and Gall, 1971: 363.—Smiley and Miller, 1971:221.

* In part.

Cambarus (*Bartonius*) *carolinus*.—Ortmann, 1905b:120*; 1906:394*, 395, 396, 397*, 398.
Cambarus carolinensis.—Adams, 1907:898, 899 (erroneous spelling).
Cambarus carolinus carolinus.—Newcombe, 1929:277, 280, 282, Fig. 1.
Cambarus (*Cambarus*) *carolinus*.—Fowler, 1912:567 (by implication). —Ortmann, 1931:148, 149.
Cambarus (*Jugicambarus*) *carolinus*.—Hobbs, 1969:107*, 108*, 139*, 142*, 143*, 144*, Fig. 9*.

Procambarus (*Hagenides*) *advena* (LeConte)

Astacus advena LeConte, 1856:402.
Cambarus Carolinus.—Hagen, 1870:87, 88*, Figs. 51–54, 165.

Procambarus (*Girardiella*) *hagenianus* (Faxon)

Cambarus Hagenianus Faxon, 1884:141.
Cambarus Carolinus.—Hagen, 1870:31, 32, 53, 74, 75, 88*.—Brocchi, 1875:27.—Faxon, 1884:140*, 141*; 1885:8, 9, 48, 54*, 55, 56, 58*, 65*, 158*, 167*, 173*.
Cambarus carolinus.—Ortmann, 1902:277, 279.—Faxon, 1914:366.—Hobbs & Villalobos, 1964:321, 322.

Cambarus (*Jugicambarus*) *gentryi* Hobbs

Cambarus (*Jugicambarus*) *gentryi* Hobbs, 1970:163.
Cambarus carolinus.—Faxon, 1914:397*.—Ortmann, 1931:149*.—Fleming, 1938:301–303.—?Pennak, 1953:456*, 464*.
Cambarus (*Cambarus*) *carolinus*.—Ortmann, 1931:149*.
Cambarus carolinus carolinus.—Fleming, 1939:312, 318–320, Plate 21.

Cambarus (*Jugicambarus*) sp., near *C. carolinus*

Cambarus carolinus.—Harris, 1903:58*, 81*, 96*, 137*, 145, 146*, 152, 154*, 158*.—Ortmann, 1905b:121, 122*, 123*, 128*, 129*, 135; 1905c:394*, 395*, 398*, 401*; 1906:451*, 452*, 453*.—Faxon, 1914: 396*, 397*, 399*.—Fleming, 1938:300.—Pennak, 1953:456*, 464*. —Hobbs, 1955:330, 332; 1959:897*.—Hobbs III, 1965:159, 162.—Holt, 1965:12.—Hobbs & Hart, 1966:36*, 38*, 41, 47, 48, 50.—Holt, 1968:32.—Hobbs, 1968b:K-15*.—Dowell & Winier, 1970:489.
Cambarus (*Bartonius*) *carolinus*.—Ortmann, 1905b:120*; 1906:397*.
Cambarus (*Cambarus*) *carolinus*.—Ortmann, 1931:147*–152*.
Cambarus (*Jugicambarus*) *carolinus*.—Hobbs, 1969:107*, 108*, 139*, 142*, 143*, 144*, Fig. 9*.

"Undescribed crayfish closely allied to *C. carolinus*."—Hobbs & Walton, 1970:860.

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* In part.

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